During the mechanical ventilation of patients in respiratory distress, pediatric patients are prone to barotrauma and volutrauma due to the inaccuracies inherent in current airway pressure measurement methods. Mechanical ventilators contain a pressure sensor proximal to the endotracheal (ET) tube and airways of the patient. Consequently, the pressure typically reported by this sensor, the peak pressure, is a sum of the alveolar pressure and the pressure required to overcome the resistance to the airways (including any mucosal occlusions in the ET tube). While alveolar pressure, an indicator of lung compliance, is the most practical standard for determining oxygenation and ventilation parameters for patients, the peak pressure is often used instead because of conventional ventilator design. The usage of peak pressure in this manner can apply damaging ventilatory output to the patient, which can significantly worsen conditions such as acute respiratory distress syndrome (ARDS) through barotrauma and volutrauma of alveoli. In some cases, inspiratory hold measurements are applied to the patient to accurately report alveolar pressure. Since the airway resistance pressure is flow dependent, the inspiratory hold method ceases air flow to the patient so that only the alveolar pressure (reported as plateau pressure) is detected. While this method provides an adequate measurement for ventilatory output based on patient lung compliance, it forces patients with critical lung conditions to cease their breathing, which can cause extreme discomfort, especially when this measurement must be repeated frequently. To avoid this problem, we aim to effectively create a device that measures the airway pressure distal to the endotracheal tube, so that a continuous, accurate measurement of alveolar pressure can be monitored to apply safe, yet effective ventilatory support to respiratory pediatric patients without an extensive patient burden.

Our design proposes an airway pressure monitoring device that will allow for accurate, real-time monitoring of lung pressures to dictate ventilation protocols. This will provide clinicians with fundamental information to effectively deliver respiratory therapy that avoids volutrauma or barotrauma caused by current ventilation protocols. This device will include a novel system to measure pressure using fiber optics to provide accurate airway pressure at the distal end of an ET tube. The proposed device will be designed to work with all variations of existing ET tubes. The system sensor data will be used as a standard to adjust ventilation parameters (inspiration duration, tidal volume, expiration duration and inspiratory pressure). Additionally, since tracheal environment may expose the sensor to mucus, the device will be constructed in a way to minimize interference from mucus and other bodily impediments.

Ventilators are incredibly prevalent in current treatment plans. For example, approximately 20-40% of patients within the ICU required the use of mechanical ventilation across 97 US hospitals1. Furthermore, when considering the pediatrics ICU, the amount of patients that are on mechanical ventilation surges to 64% for the first 24 hours2. ARDS patients, both domestically and globally, experience roughly a 40-60% incidence of barotrauma, with a similar rate of mortality3. Through this device, a safer approach to protective lung ventilation can be achieved, strongly impacting patients both in the United States and internationally.

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